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BEFORE THE
POSTAL REGULATORY COMMISSION
WASHINGTON, D.C. 20268-0001

Mail Processing Network Rationalization Service Changes, 2012	Docket No. N2012-1

DIRECT TESTIMONY OF SUBRAMANIAN RAGHAVAN

ON BEHALF OF THE

PUBLIC REPRESENTATIVE

April 23, 2012

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I. INTRODUCTION

A. Autobiographical Sketch

My name is Subramanian Raghavan and I am a Professor of Management Science and Operations Management at the University of Maryland. I have been teaching there since 1998. Prior to that I worked in the telecommunications industry. My expertise is in the field of applied optimization. I obtained my Ph.D. in Operations Research from the Massachusetts Institute of Technology.

Much of my work has focused specifically on network optimization, and many of my academic papers are motivated by real-world optimization problems. Areas in which I have conducted research include telecommunications network design, supply chain and logistics, game theory and auctions, as well as data mining. I have published over 40 papers in these areas. I have extensive experience directing research as I have served on over 30 doctoral dissertation committees. I hold two patents, and have won numerous awards for my research work. These awards include

1) the Dantzig award for the best doctoral dissertation in operations research,
2) the INFORMS Computing Society Prize (twice); once for innovative contributions to the field of data mining, and a second time for my contributions to public sector auction design,
3) the Management Science Strategic Innovation Prize from the European Operations Research Society for my research contributions applying optimization techniques to telecommunications problems,
4) the Glover-Klingman Prize for the best paper in the journal Networks,

5) Finalist for the European Operations Research Society Excellence in Practice Award, and

6) Finalist for the Wagner Prize for Excellence in Operations Research Practice.

I have edited six books ranging from topics in vehicle routing and logistics to network design. I teach statistics, optimization, and quantitative decision making courses at the University of Maryland, and have previously won the Legg-Mason Teaching Innovation award at the Smith School of Business.

The following is a sampling of some of my research papers in the area of applied network optimization. They include papers that are based on real-world optimization problems.

"Multi-period Traffic Routing in Satellite Networks," European Journal of Operational Research, **219**(3), 738-750, 2012, with I. Gamvros.

"The Mobile Facility Routing Problem," Transportation Science, **45**(3), 413-434, 2011, with R. Halper.

"Dual-Based Local Search for the Connected Facility Location and Related Problems," INFORMS Journal on Computing, **22**(4), 584-602, 2010, with M. G. Bardossy.

"The Regenerator Location Problem," Networks, **55**(3), 205-220, 2010, with S. Chen and I. Ljubic.

"Investment Analysis and Budget Allocation at Catholic Relief Services," Interfaces, **36**(5), 400-406, 2006, with I. Gamvros and R. Nidel.

"Long Distance Access Network Design," Management Science, **50**(3), 309 325, 2004, with R. Berger.

B. Purpose and Scope of Testimony

The purpose of my testimony is to evaluate the Postal Service's analysis of the design of the rationalized mail processing network under the proposed service standard (Docket No. N2012-1). To that end my analysis focuses mainly on Postal Service witness Rosenberg's (USPS-T-3) testimony that is at the heart of the Postal Service's case. I also discuss and analyze some of the testimony and analysis of Postal Service witnesses Martin (USPS-T-6), Neri (USPS-T-4), and Bradley (USPS-T-10).

My testimony examines the models used and analysis conducted by Postal Service witness Rosenberg, and points out several shortcomings in this analysis. Witness Bradley uses productivity improvement estimates and transportation cost savings estimates provided by witnesses Neri and Martin respectively to compute cost savings in the rationalized network[1] under the proposed service standard. To that end, I examine the calculations underlying the productivity improvements provided by witness Neri, and transportation costs savings provided by witness Martin. I point out some fundamental problems in the assumptions relating to these calculations. Since these calculations inform witness Bradley's calculation of cost savings, they significantly affect these numbers, implying that the suggested cost savings may not be achievable.

An important question that is not addressed in Postal Service case set forth in Docket No. 2012-1 is an estimate of the cost savings associated with an optimized mail processing network that preserves the current service standard. This would provide a comparative analysis to the rationalized network under the proposed service standard.

[1] I use the term rationalized network to refer to the rationalized mail processing network under the proposed service standard.

To that end I run witness Rosenberg's Logic Net optimization model under the current service standard. Notwithstanding the fact that I cannot provide specific cost savings estimates (the model does not provide these), the structure of the optimized network[2] under the current service standard in terms of the number of mail processing facilities suggests that significant cost savings may be achievable while preserving the current service standard.

C. Library References Sponsored

Along with this testimony I am sponsoring the following public library references: PR-LR-2012-1/1 through PR-LR-2012-1/3. I am also sponsoring one non-public library reference associated with my testimony: PR-LR-201201/NP1.

[2] I typically use the term optimized network to refer to the optimized mail processing network under the current service standard. When not clear from context, I explicitly make clear whether I am referring to the current or proposed service standard.

II. ANALYSIS OF POSTAL SERVICE OPTIMIZATION MODEL & COST SAVINGS CALCULATIONS UNDER PROPOSED SERVICE STANDARDS

A. Overview of Analysis

In this section, I first consider the Postal Service's optimization model under the proposed service standard. I examine the analysis, and associated cost savings calculations. I first discuss witness Rosenberg's testimony and analysis that forms the core of the Postal Service's analysis. I then discuss witnesses Martin, Neri, and Bradley's testimony and point out some significant concerns that underlie the assumptions (and calculations) associated with the cost savings estimates that follow from their analysis. In Section III, I discuss potential cost savings under the current service standard, which to some extent provides a comparative analysis between the optimized network under the proposed and current service standards.

B. Evaluation of Postal Service Witness Rosenberg's Analysis

Witness Rosenberg describes the process employed to develop an operating plan that would allow the Postal Service to use its equipment and facilities more efficiently. The first step employs an Excel based scoring tool to evaluate different options for expanded mail processing windows. The second step is an optimization model (run using Logic Net) to determine which mail processing facilities to keep open, and to determine an assignment of 3-digit ZIP Codes to mail processing facilities. These two steps provide starting points that were then refined to determine the final operating windows and the mail processing facilities and 3-digit ZIP Codes to mail processing assignments in the rationalized network. Consequently, these two modeling efforts are of significant importance in determining the Postal Service's rationalized network as they provided a set of options that Postal Service management was then able to refine. The remaining steps were focused on checking the feasibility of the proposed solutions. These included modifying the 3-digit ZIP Code to mail processing facility assignments and performing a detailed equipment analysis.

The analysis I undertook focused on understanding the assumptions, mathematical models, and calculations described in witness Rosenberg's testimony. The purpose was to determine whether the models, as methodologies, provide reasonable approximations to address the Postal Service's problem of designing the rationalized network. Since witness Rosenberg's analysis informs witness Bradley's calculations of the cost savings of the rationalized network, it is important to ascertain that the models used are reasonable approximations for the rationalized network optimization problem.

The analysis below focuses on the first two steps of witness Rosenberg's analysis, the Excel scoring tool and the Logic Net optimization model. In these two cases, witness Rosenberg's testimony and the libraries available provided sufficient documentation in the timeframe I was allotted to carefully review these two pieces of the analysis. The latter parts of witness Rosenberg's analysis (USPS-T-3 21-33), where the detailed equipment modeling is performed, are not documented to an extent that it was possible for me to replicate the analysis. Nor was it possible for me to ascertain the analysis to the extent that I could replicate it from the library references provided.[3]

1. Analysis of Postal Service's Excel Scoring Tool to Evaluate Expanded Operating Windows

Postal Service witness Rosenberg uses an Excel scoring tool to evaluate the costs and benefits of expanding the operating windows and travel times between collection points, mail processing centers, and delivery units (see USPS-T-3 pages 4-5).

Specifically, the scoring tool takes as input possible values for travel time for C2C (collection to cancellation) trips and D2D (DPS to delivery) trips and possible lengths of operating windows for cancellation and DPS; the tool iterates through the set of combinations, calculating for each one (1) the corresponding start and arrival times for the various transportation segments, (2) the corresponding start times, CET (critical entry time), and clearance times for the various processing operations, (3) the feasibility of the solution, (4) the number of machines required, (5) the associated transportation, labor, overhead, and administrative costs, and (6) a scenario "score".

While the calculations are detailed, there are unfortunately some significant weaknesses of the model built within the Excel scoring tool. It is important to note that the scoring tool is a *single facility model*. Witness Rosenberg states that she "assumed national standardization of mail processing", meaning that the start time and the end

[3] Witness Rosenberg's testimony describes at a high level the analysis associated with AFCS, DBCS, AFSM100, APPS, and APBS equipment determination. Library reference USPS-LR-N2012-1/18 contains a DPS tool that is used to determine DBCS requirements. I did not find any library references that contained the calculations used to determine AFCS, AFSM100, APPS, and APBS equipment. I found the documentation in the DPS tool and within witness Rosenberg's testimony insufficient to replicate the equipment determination analysis.

time for each processing step were the same for all mail processing facilities. *Id*. at 6. In addition, she assumed that the mail processing workload was the *same for all facilities*, and the workload was spread evenly across the 3,119,884.69 square miles of the contiguous states of the United States. Therefore, the scoring tool evaluates the impact on the processing windows and the associated costs for a representative mail processing facility in *isolation*. Total costs are computed by multiplying the single facility costs by the number of (identical) facilities required. As one will see, these assumptions make the tool provide *grossly inaccurate* assessments of the number of facilities required to process the workload, and as such lead to some healthy skepticism about the validity of its results.

It is reasonable to make a large number of approximations or simplifying assumptions in building a model for strategic purposes. However, it is important that such approximations or simplifying assumptions do not take the model too far from the problem it is trying to solve to the extent that there are questions about the results of the model. In simple terms, any model that is used for planning purposes should be tested in some form, if possible, to confirm its validity. To this end, I tested the Excel scoring tool by using the current service standard and operating windows. If the Excel scoring tool's calculations are reasonable, then it should provide a number of facilities in the ballpark of the current number of mail processing facilities.

Scoring Tool Overview

The scoring tool is provided as an Excel workbook in library references USPS-LR-N2012-1/14 and USPS-LR-N2012-1/NP3. The "Assumptions" worksheet holds all of the data inputs to the tool. The scenario options are mainly defined by the following cells:

Cell	Description
E22	Number of days for earliest delivery (1= current standard, 2= proposed service standard)
J12, K12, L12	C2C trip hours and D2D trip hours (J12 = min number of hours, K12 = max number of hours, L12 = increment value)
J17, K17, L17	Cancellation processing window (J17 = min number of hours, K17 = max number of hours, L17 = increment value)
J20, K20, L20	DPS processing window (J20 = min number of hours, K20 = max number of hours, L20 = increment value)

Additional options can be set in cells E21 (round cost of workhour shifts to 8 hours), J24 and K24 (turn hubbing on), J25 and K25 (number of trips from collections to cancellation) and J26 and K26 (number of trips from DPS to delivery). To run the tool, one clicks on "Generate Iteration Results", which starts a Visual Basic macro to loop through all of the iterations; for each combination of settings, the calculations on the "Calculations" worksheet are completed and the corresponding results are added to the "Results" worksheet, if the scenario is feasible.

The top two sections of the worksheet "Calculations", labeled "Operation" and "Transportation", use the trip hours and the processing windows information from the assumptions to do the flow-through sequence of the processing steps and the transportation segments. At the end, there are start times, critical entry times, and clearance times for each operation and trip start times and arrival times for each transportation segment. The third section, labeled "Locations", calculates the equipment requirements and the facility costs by operation. The fourth section, labeled "Cost

Summary", computes the scenario costs and compares them to the defined baseline costs. The fifth section, labeled "Feasibility", checks whether the combination of trip hours and processing times result in a feasible operations plan. There are seven criteria, all of which must be true for a feasible solution:

1. Last Collection Trip Arrives Before Collection CET
2. Last Outgoing Trip Arrives Before Incoming CET
3. Incoming CT is after Incoming ST (start time)
4. Trip to 918 (DPS) starts before the 918 is scheduled to start
5. 1st Trip to Delivery arrives before Delivery Start Time
6. AFCS needed for cancellation < current inventory
7. Total Automation needed < current inventory

To reflect the current service standards for First Class Mail, I assume that the maximum length of C2C and D2D trip hours is about 2 hours.[4] I refer to Figure 5 on page 13 of witness Neri's (USPS-T-4) testimony for the appropriate cancellation window and DPS window. In Figure 5 of USPS-T-4 the cancellation window is 6.5 hours, from 3:00 p.m. to 9:30 p.m. However, since the first trip from collections does not begin until 4:00 p.m. in the scoring tool (worksheet "Assumptions", cell E31) and travel time between the earliest collection and cancellation times must be accounted for, I set the cancellation window to 4 hours. In witness Neri's Figure 5, the DPS window is 8 hours, from 11:00 p.m. until 7:00 a.m. The scoring tool takes the DPS window for each phase

[4] In the proposed service standard the maximum length of the C2C and D2D trip hours is four hours. Witness Rosenberg's Scoring Tool makes C2C and D2D hours equal to each other (cells J12, K12, and L12). Based on (i) the current operating windows, (ii) current average distance from post office to mail processing facility (see response to PR/USPS-T3-24), (iii) the current maximum distance from post office to mail processing facility (see response to PR/USPS-T3-33), as well as (iv) discussions with Public representative technical staff; it was my assessment that a maximum C2C and D2D trip length of two hours is a reasonable approximation of the current service standard.

as an input, so I set the DPS window to 4 hours. Therefore, I set the following options in the scoring tool:

Cell	Description
E22	Number of days for earliest delivery: 1
J12, K12, L12	C2C trip hours and D2D trip hours: from 1.75 hrs to 2.25 hrs in increments of 0.05 hrs
J17, K17, L17	Cancellation processing window: 4 hours
J20, K20, L20	DPS processing window: 4 hours

With these settings, the scoring tool iterates over the trip hour settings, doing its calculations for a 4 hour cancellation window and a 4 hour DPS window for each DPS phase. The tool reports that there are three feasible solutions (when worksheet "Assumptions" cells K25 and K26 are both set to 2, meaning that there are two C2C and two D2D trips); the partial results are shown in Table 1 below.[5]

Table 1: Results of Excel Scoring Tool Under Current Service Standard

Trip Time	# Facilities	Cancellation Window	DPS 1st Pass	DPS 2nd Pass
1.8	928	17:25 – 21:25	23:12 – 3:12	2:32 – 6:32
1.85	878	17:26 – 21:26	23:09 – 3:09	2:29 – 6:29
2.05	715	17:32 – 21:32	22:57 – 2:57	2:17 – 6:17

The cancellation window and the DPS window for these three feasible solutions are in line with the windows in Figure 5 of USPS-T-4. However, the number of facilities far exceeds the number of mail processing facilities currently operating. Because the

[5] Library reference PR-LR-N2012-1/1 contains the settings and results of this analysis.

number of facilities is calculated only as a function of the C2C/D2D trip hours and <u>does not depend on the operating windows or the workload volume, the number of facilities can be grossly exaggerated</u>. For example, if I set the C2C and D2D trip hours to 1.3 hours with the 4 hour cancellation window and the 4 hour DPS window, the scoring tool calculates the number of facilities to be 1778!

In other words, for the current mail processing windows, the Excel scoring tool requires a number of facilities far in excess of the 487 mail processing facilities there are in the mail processing network (USPS-T-4 at 3). It is true that the tool was used as a starting point for discussions on proposed operating windows; and further calculations were done at later steps to validate the final proposed solutions in later stages of the Postal Service and witness Rosenberg's analysis. However, since the tool was used to analyze different windows and come up with a set of alternatives as a starting point, it is important that its results be viewed as "reasonable". In this case, the results of the scoring tool should be treated with *significant skepticism*, since it provides results that are at odds with the current service standard and mail processing windows.

2. Analysis of Postal Service's Logic Net Optimization Model

Once the operating windows were established the second step of witness Rosenberg's analysis focused on determining the configuration of the mail processing network under the proposed service standard.

The Postal Service's problem of configuring the rationalized mail processing network can be described at a high level as follows. One is given a set of potential mail processing facility (or plant) locations, each with a set of associated facility costs (which includes fixed and variable costs) and mail processing capacity. One is also given a set of 3-digit ZIP Codes, each with associated demand, and transportation costs from 3-digit ZIP Code to mail processing facilities. The problem is to determine the optimal set of mail processing facilities to open in order to minimize the overall facility and transportation costs. The problem is one that has been studied previously in the operations research literature.[6] I have studied and solved similar problems during my career in the telecommunications industry. In the telecommunications context switches take the role of mail processing facilities and area codes take the role of 3 digit ZIP Codes.

Witness Rosenberg uses the Logic Net software to solve her model of the Postal Service's mail processing network configuration under the proposed service standard. While the modeling and solution methodology are well grounded in the field of optimization there are several issues in the analysis of witness Rosenberg that raise some concerns. First, she completely ignored the transportation cost between mail processing facilities in her analysis.[7] Plant to plant transportation cost is an important

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[6] This problem is referred to as the "Capacitated Hub Location Problem with Single Assignment" in the operations research literature. The following is a sample of papers that discuss the problem and solution procedures. The paper by Ernst and Krishnamoorthy specifically describes a postal mail processing network as a motivating example.

1) A.T. Ernst and M. Krishnamoorthy. Solution algorithms for the capacitated single allocation hub location problem. *Annals of Operational Research*, **86**:141–159, 1999.
2) G. Carello, F. Della Croce, M. Ghirardi, and R. Tadei. Solving the Hub Location Problem in Telecommunication Network Design: A Local Search Approach. *Networks*, **44**(2): 94-105, 2004.
3) M. Labbe, H. Yaman, and E. Gourdin. A branch and cut algorithm for hub location problems with single assignment. *Mathematical Programming*, **102**(2):371–405, 2005.
4) I. Contreras, J.A. Díaz, E. Fernández, "Branch and price for large-scale capacitated hub location problems with single assignment", *INFORMS Journal on Computing*, **23**: 41-55, 2011.

[7] The problem obtained by ignoring plant to plant transportation cost the problem is referred to as the "Capacitated Facility Location Problem" in the operations research literature. This is also a classic and well-studied problem in the academic literature. For a nice "technical" survey on the capacitated facility location problem, see: V. Verter. Uncapacitated and Capacitated Facility Location Problems. Chapter 2 of Foundations of Location Analysis. H. Eiselt and V.Marianov (editors). Springer, 2011. Thus from a

consideration because the analysis of witnesses Martin and Bradley indicate that plant to plant transportation cost is a significant portion of the transportation costs of the Postal Service network (witness Bradley's testimony indicates that in FY2010 plant to plant transportation costs amounted to $865 million while plant to post office transportation costs amounted to $1,047 million). *See* Tables 12 and 15 in USPS-T-10. In the optimization problem there is a natural tension between the plant to plant transportation cost and the post office (3-digit ZIP Code) to plant transportation cost. If the plant to plant cost dominates, then the model will open plants closer to each other and have longer plant to post office links. If the post office to plant cost dominates, then the plants will be located farther from each other and closer to the post office. When these costs are closer to each other the tension between them determines the solution. The traffic matrix indicating the mail flows between different originating and destinating 3-digit ZIP Codes also play a significant role in determining the optimal solution. In other words, if a lot of the mail stays within a mail processing facility because it both originates and destinates in 3-digit ZIP Codes serviced by the facility, then it won't need to be transported plant to plant. All of these different factors affect the optimal layout of the network.[8] <u>Using a model that included the plant to plant transportation costs and included a traffic matrix of mail volumes amongst the 920 3-digit ZIP Codes would have helped in identifying a *better* starting point for discussions with the domain experts</u>.

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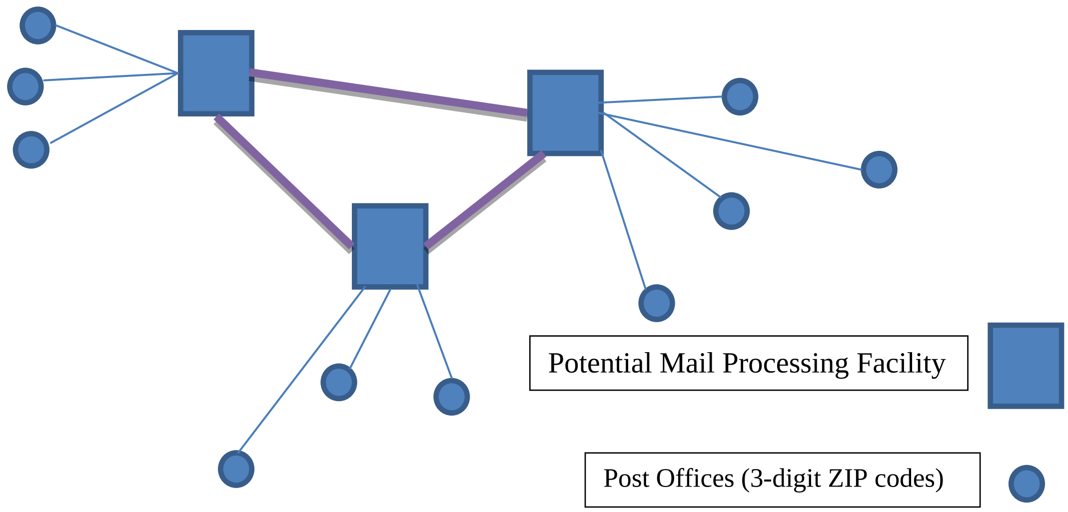
technical perspective witness Rosenberg solves a capacitated facility location problem, instead of a capacitated hub location problem with single assignment.

[8] One mitigating factor in witness Rosenberg's model is the 4 hour drive time limit on 3-digit ZIP Code to plant assignments. To a small extent this dampens the tension between the plant to plant transportation cost and the plant to post office transportation cost.

Figure 1: Pictorial representation of Capacitated Hub Location Problem with Single Assignment



A second criticism is that witness Rosenberg does not do any iterative analysis. Although her testimony suggests that the process was iterative (where the high level model was vetted through multiple rounds of local input to determine the facilities to move forward in studying), it is not truly iterative in the sense that the mathematical analysis was not redone after the iterative use of local input. *See* USPS-T-3 at line 10, page 3. For example, the proposed operating windows in Figure 3 of USPS-T-3 and Figure 8 of USPS-T-6 are not used in the optimization model. Instead witness Rosenberg runs the Logic Net model with a 12 hour window for cancellation. Once the cancellation windows were shortened (as is the case in Figure 8 of USPS-T-6) it would have been prudent to rerun the Logic Net optimization model. A longer window effectively increases the capacity of the facilities. Since the windows were shortened, it would result in a solution requiring more than the 177 processing facilities activated by the Logic Net optimization model.

Many of the facilities opened by the model are deactivated. Specifically 61 of the facilities opened by the Logic Net model were deactivated and 71 facilities not opened by the Logic Net model were activated. These changes were made on the basis of Area management expertise and judgment about feasibility. *See* USPS-T-3 at 17. Again, some of the area management expertise could have been incorporated within an optimization model. To be specific, let us consider the solution obtained by the Logic Net model as solved by witness Rosenberg. It does not open the Dulles airport mail processing facility, but after consulting with area management expertise it is activated. Clearly, there are some facilities that should be favored or always open in any solution. This can be accomplished in most optimization software by indicating that a facility must be necessarily opened. That allows the inclusion of domain knowledge to open facilities that absolutely must be opened in the rationalized network, and lets the model focus on optimizing the remaining facilities to open (which <u>ensures that the network even after adjustments that incorporate Area management expertise remains optimized</u>). Given that this type of iterative analysis was not done, the rationalized network designed under the proposed service standard may not be as efficient as possible.

A third issue deals with the use of average mail volumes within the Logic Net optimization model. Mail volume is variable and it is important to plan so that there is adequate capacity for peak loads. In determining 3-digit ZIP Code to mail processing facility assignments the average traffic volume from each 3-digit ZIP Code is used. The Logic Net model ensures that the total average traffic volume assigned to a mail processing facility does not exceed its capacity. While this is feasible for the average mail volumes, it could be the case that an assignment may bring a facility close to its capacity with the average workload. Such a facility would have difficulty handling the mail volumes on peak load days. To some extent this issue is mitigated by witness Rosenberg analysis in the third part of her study where detailed equipment modeling is done using the 95th percentile of DBCS mail volume. However, incorporating peak load considerations in the Logic Net phase <u>might have yielded a better starting point for discussion with Area management</u>.

A fourth issue concerns how workload volume was decomposed to the 3-digit ZIP Code level and the implications to the transportation cost calculated in the Logic Net optimization model. Witness Rosenberg describes how the Fiscal Year 2010 MODS data were decomposed. USPS-T-3 at 15, footnote 20. To start, to get the originating demand from post offices to plants, truck information from April 2010 was retrieved from the Transportation Information Management Evaluation System (TIMES). The "TIMES" worksheet in the workbook USPS.LR.N2012.1.13.xls lists for each 3-digit ZIP Code a "totalutil" value and a "count". For each mail processing facility, a facility value is calculated as the sum of the "totalutil" values of the 3-digit ZIP Codes that are currently assigned to that mail processing facility. Then, for each 3-digit ZIP Code, a percentage contribution is calculated by dividing its "totalutil" value by the facility's total value. Multiplying this percentage contribution by the appropriate FY2010 MODS workload provides the 3-digit ZIP Code originating workload by shape and process step.

Next, to get the destinating demand from plants to post offices, Origin Destination Information System (ODIS) information was used in a similar manner. The "ODIS" worksheet in the workbook USPS.LR.N2012.1.13.xls lists a value for each 3-digit ZIP Code and for each shape and process step. For each mail processing facility, a facility value is calculated as the sum of the “ODIS” values of the 3-digit ZIP Codes that are currently assigned to that mail processing facility. Then, for each 3-digit ZIP Code, a percentage contribution is calculated by dividing its “ODIS” value by the facility’s total value. Multiplying this percentage contribution by the appropriate FY2010 MODS workload provides the 3-digit ZIP Code destinating workload by shape and process step.

There are thirteen categories of shape and process step in the model that eventually get rolled up into three products (LETTER, FLAT, PARCEL). For the categories CANC, L-OGP, L-OGS, F-OGP, F-OGS and P-OGP, both the originating and destinating workloads are calculated. However, *the originating workload* (as calculated using the TIMES percentage) is the workload that is used in calculating the demand (square footage requirements) for a 3-digit ZIP Code. Therefore, using the originating workload to calculate demand means that the transportation cost only captures the cost of the originating (post office to plant) traffic. If the values of originating traffic and destinating traffic from a 3-digit ZIP Code are balanced (meaning approximately the same volume is sent from post office to plant and plant to post office) then considering just one of the two legs (post office to plant or plant to post office) is reasonable. Otherwise, one should use the average of the originating and destinating volumes since the originating and destinating percentages for a 3-digit ZIP Code can be quite different. Table 2 below highlights just three examples of CANC workloads (from “CANC” worksheet in USPS-LR-N2012-1/LR13) that differ significantly in the originating and destinating percentages:

Table 2: Differing Originating and Destinating Workload Percentages		
3-digit ZIP Code	TIMES % (originating)	ODIS % (destinating)
012	49.6	1.27
029	17.3	72.29
233	15.4	92.5

3. Analysis of Postal Service's Detailed Equipment Modeling

Once the operating windows and mail processing facilities were determined, the next step of witness Rosenberg's analysis focused on determining the equipment requirement at each of the mail processing facilities configuration of the mail processing network under the proposed service standard.

Three concerns emerge from my evaluation of this analysis. They are all interrelated and specifically tie into the issue of peak load capacity.

The first concern is related to the peak load and the percentiles used for the analysis. Table 3 below provides percentiles and peak load factors used in witness Rosenberg's equipment determination calculations. The table also provides the peak factors for the 96th, 97th, 98th, and 99th percentile. These are in responses of witness Rosenberg to PR/USPS-T3-45 and PR/USPS-T3-46. This provides a sense of how spiky the daily mail volumes associated with different operations are, and whether there would be adequate capacity in the mail processing network on peak volume days.

Table 3: Peak Factors for Fiscal 2010						
	Percentiles and Peak Factors				Percentile Used	Peak Factor Used
	96th	97th	98th	99th		
Cancellations	181%	196%	222%	238%	75th	115%
Outgoing Primary Letters	172%	182%	197%	213%	95th	155%
DPS Letters	141%	143%	149%	155%	95th	120%
Outgoing Primary Flats	159%	165%	176%	190%	95th	150%
Incoming Primary Flats	164%	169%	180%	193%	95th	120%
Incoming Secondary Flats	166%	171%	180%	191%	95th	120%

Table 3 above shows that cancellation volume can be highly variable. While cancellation equipment planning is done for a peak factor of 115 percent, on peak load days the cancellation volume can be close to double that! Similarly, incoming primary and secondary flats equipment determination is done for a peak factor of 120 percent, while the peak load volume can approach close to 200 percent. This raises a natural question about the use of an appropriate percentile value for equipment planning. When traffic is extremely spiky a higher percentile value (and higher peak factor) may be more appropriate. The issue of peak volume days and planning for the peak gets trickier if peak volume days occur back to back (for example in mid-December or close to Mother’s day in May). When a network does not have sufficient capacity to handle its mail volume, the mail will slow down as excess mail that cannot be handled waits for capacity in the network. If a peak volume day is followed by a light volume day, there is sufficient capacity in the network the following day to deal with the excess volume and get the network back to its planned operational status. However, if the days with peak load occur in a back to back fashion then there is no slack in the network to handle the peak load, and the repetition of peak load in a back to back fashion for several days could cause severe disruptions in the ability to handle and move mail through the network. Thus when the peak load days occur in a back to back fashion, and the daily mail volumes are spiky it may be prudent to plan for percentiles and peak load factors that are at the 98th or 99th percentile.

A second critical issue is that under the proposed service standard a large quantity of mail that previously was handled overnight (and thus went into and out of the mail processing facility very quickly) is now going to be held at a mail processing facility for processing the next day. Thus in the new environment, on a given day one deals with a much greater inventory of mail---the originating mail for a given day and the destinating mail (some of which was originating mail the previous day at the mail processing facility) for a given day. Previously (*i.e.*, under the current service standard) the same piece of mail was frequently originating and destinating on the same day at the same mail processing facility. Under the proposed service standard and mail processing environment the same piece of mail will not count as originating mail and destinating mail on the same day. From an operational perspective, <u>the implication of this observation is that the staging space for mail is going to increase very significantly</u>. The analysis of the layout of a facility needs to account for this critical fact, and ensure that there is adequate space to deal with the originating and destinating mail inventories separately. None of witness Rosenberg's (or any of the other Postal Service witnesses) analysis discusses this issue. In witness Rosenberg's analysis there is an increase of staging space for machinery (at 20 percent) to deal with the additional workload that will be available at the start of the window. However, there is no discussion of staging space to store destinating mail overnight for processing the next day. Again, this can become a critical issue on peak volume days if there is inadequate space to store the inventory of mail. If peak volume days occur in a back to back fashion, that would compound the problem causing significant slowdowns in the mail processing network.

A third concern is the lack of any simulation studies to analyze a mail processing facility under the proposed service standard. There is no detailed simulation analysis of the layout of a mail processing facility under the proposed service standard (which could be different because of the difference in how mail inventories will flow through the mail processing network). Conducting a simulation study, with appropriately modeled mail volumes, equipment, and facility specific information would provide the most convincing analysis that the facilities in the proposed mail processing network can adequately handle peak load volumes, and there is adequate equipment and capacity in the network.

C. Evaluation of Witness Martin's Analysis

Witness Martin describes the process employed to estimate the reduction in transportation activity anticipated from the service standard changes and the network rationalization. Her analysis considers separately three components: plant to plant transportation, plant to post office transportation, and surface vs. air transportation. The results of the analysis are estimates of (1) a reduction in plant to plant trips, (2) a reduction in plant to post office operating miles, and (3) the increase in mail volume transported by air. The estimates are used directly in witness Bradley's calculations of the cost savings of the rationalized network under the proposed service standard. Therefore, it is important that the analysis underlying the estimates is as rigorous and as complete as possible.

1. Plant to Plant Network Rationalization

Witness Martin asserts that "a reduction in the number of processing facilities in the postal network will significantly reduce the number of individual links in the transportation network." USPS-T-6 at 6. To illustrate her point, witness Martin provides two figures of hypothetical networks. Figure 1 (USPS-T-6 at 7) is intended to show a portion of the mail processing network under the current service standard. There are 10 plant to plant links connecting 5 plants in 2 service areas. Figure 2 (USPS-T-6 at 8) is intended to show a rationalized network with 1 link connecting 2 plants. Witness Martin asserts that, even if the mail volume remains constant between the two areas and the number of trips needs to be increased, the overall effect will still be a net decrease in transportation activity. The problem with comparing the two figures is that Figure 1 represents the worst-case scenario in terms of the number of required links. In an optimized transportation network, hubs could be used to reduce the number of links. Consequently, while the rationalized network may have fewer links, the decrease will not be as dramatic as depicted in Figures 1 and 2 of witness Martin's testimony.

In her original testimony, Martin states that she analyzed a subset of 322 routes (not selected via statistical sampling) and 1,723 trips that comprised those routes. A manual process was used to determine which trips might no longer be needed in the rationalized network. The result of the analysis is shown in Table 4 below:

Table 4: Plant to Plant Trip Reduction[9]

Region	Total Routes	Total Trips	Potential Trips Eliminated	Percent Reduction
Northeast	40	247	86	35%
Eastern	102	434	156	36%
Cap Metro	48	290	89	31%
Great Lakes	51	262	67	26%
Southwest	38	168	44	26%
Western	38	210	34	16%
Pacific	5	112	4	4%
<u>Total</u>	**322**	**1723**	**480**	**24.71%**

Based on her analysis, witness Martin estimates that *the number of plant to plant trips could be reduced by 24.71 percent*. However, this number cannot be extrapolated

[9] The information is extracted from USPS-LR-N2012-1/11.

to the entire network because it is based on a random subset of routes that is most likely not representative of the network.

In her supplemental testimony, Martin reports that she analyzed ALL of the routes in the network and additionally incorporated feedback from each Area office as to which routes were candidates for elimination. The result of the analysis is shown in Table 5 below:

Table 5: Revised Plant to Plant Trip Reduction[10]

Region	Total Routes	Total Trips	Potential Trips Eliminated	Percent Reduction
Northeast	107	2450	476	19%
Eastern	305	2539	200	8%
Cap Metro	117	1073	57	5%
Great Lakes	191	1568	139	9%
Southwest	216	2286	219	10%
Western	200	4095	173	4%
Pacific	102	2194	83	4%
Total	**1,238**	**16,205**	**1,347**	**8.44%**

There are several points to note here. First, the 8.44 percent is a simple average of the 7 areas, not a weighted average. Second, the reduction is in the number of trips,

[10] The information in this table is extracted from USPS-LR-N2012-1/77.

with no indication as to the length or frequency of the trips eliminated.[11] Third, a manual process was used to determine how volume would flow in a rationalized network. There is no indication as to how any necessary increases in trip frequency were considered or whether any of the new transportation links (if necessary) were incorporated. Thus while a lower estimate in the revised testimony is probably closer to the actual savings in the rationalized network, <u>it is still not clear if the number of 8.44 percent is reliable enough to take forward into witness Bradley's calculations</u>.

2. Plant to Post Office Network Rationalization

For the plant to post office network, witness Martin asserts that, within a geographic area, deactivating some mail processing facilities and consolidating two service areas into one will lead to a reduction in operating miles for that area. However, if there are fewer mail processing facilities, at least some mail is being transported a longer distance, so it cannot always be the case that consolidation will lead to a reduction in operating miles. In fact, in the rationalized network one would expect there to be significant savings in the plant to plant transportation portion and an increase in the post office to plant transportation costs.

In her original testimony, to assess the impact of network rationalization, witness Martin analyzed the trips contained within 14 AMP studies that were available on December 15, 2011 to identify trips that could be eliminated. For each AMP study, the difference between the current annual miles and the proposed annual miles was

[11] Although library reference USPS-LR-N2012-1/77 contains the annual costs associated with the trips they are not used in computing the plant to plant trip reduction. In other words, the calculation is a computation of the number of trips eliminated with no corresponding cost savings calculation.

calculated. Then, the average of the differences was calculated, which was 13.68 percent. This estimate of a 13.68 percent reduction in operating miles cannot be extrapolated to the entire network as there is no reason to assume that the 14 studies are representative of the complete set of studies.

In her supplemental testimony, witness Martin updates the analysis to include all of the routes within the AMP studies that were approved by the Postal Service and announced on February 23, 2012. *See* USPS-ST-2. There are 206 studies included in the new analysis. Witness Martin reports in her supplemental testimony that she estimates that network rationalization could lead to a reduction of 3.18 percent in the number of plant to post office operating miles. The 3.18 percent reduction is a simple average of the differences between current annual miles and proposed annual miles in the 206 studies. Looking at the data for the individual studies, I see that, for 59 of the studies, there is an increase in the miles, ranging from 0.04 percent to 318 percent. For 132 of the studies, there is a decrease in the miles, ranging from 0.01 percent to 100 percent (indicating the facility was closed). For the remaining 15, the change was 0 percent.

Finally, witness Martin describes opportunities for savings in costs of plant to post office and post office to plant trips by "scheduling trips between plants and post offices throughout the day and into the evening when collection mail will be available for transport from the post offices to the plants." There are two issues that might prevent such savings. First, depending on how far the post office is from the plant, and when collection at post office must occur transportation may have to leave a plant as early as 2:00 pm to avail of such savings. However it is unlikely that 2nd pass DPS mail would be available that early (since DPS sortation starts only at noon), which would prevent such a trip. Further, from witness Martin's cross-examination by the public representative it is my understanding that it would be unlikely to have separate plant to post office transport for letter, flats, and parcels/bundles. *See* Tr. 4/1212-13. In that case, based on the proposed operating plan from Figure 8 of USPS-T-4 it is unlikely that the opportunities that witness Martin describes could be availed off (meaning that plant to post office trips may take place later in the day when all three types of mail are ready for dispatch to the post office).

In summary, in the rationalized network under the proposed service standard one might expect the plant to post office (and post office to plant) transportation costs to increase slightly (or stay level). In this regard the savings estimate of 3.18 percent in the number of plant to post office operating miles should be taken with some caution.

D. Evaluation of Witness Neri's Analysis

Witness Neri draws upon his extensive operational experience and knowledge of the Postal Service's network to provide an overview of the current mail processing network, some of the operational challenges associated in the current mail processing network, and discusses the proposed mail processing network with some key insights about how some of the operational challenges are mitigated in the proposed mail processing network.

Figure 12 of USPS-T-4 provides an estimate of productivity improvements associated with different operations in the rationalized network under the proposed service standard. These numbers are critical, as they inform the calculations of witness

Bradley on the cost changes due to productivity improvements. *See* USPS-T-10 at 11-17. Using these numbers witness Bradley estimates cost savings of $964 million from productivity improvements.

In response to POIR No. 1 Question 7, witness Neri provides library references USPS-LR-N2012-1/49 and 50. The calculations in USPS-LR-N2012-1/50 are based on smoothing the workload perfectly (or evenly) over a 24 hour day. These calculations show that there would be an approximately 28 percent lower staffing level across all operations. This number of 28 percent (deflated to 15 percent to account for the fact that all operations will not be perfectly spread) along with witness Neri's operational experience are then used as a basis to provide the productivity improvements in Figure 12 of USPS-T-4.

The analysis aggregates data across the country by hour and type of mail. These are then used to calculate the needed complement, by hour, for each shape. The Postal Service uses eight hour tours for staffing. By using the maximum value of staffing required for each 8 hour tour the needed staffing is computed. Next, the workload is smoothed evenly over 24 hours and staffing requirements are computed again based on the eight hour tours. These calculations inform the decrease in staffing and productivity improvement estimates.

There are several critical assumptions associated with this computation. As I will show any changes from these assumptions result in widely varying estimates of productivity improvements, thereby <u>raising significant doubts about the savings due to productivity improvements in the Postal Service's case</u>.

The first critical (and most problematic) assumption in this analysis and USPS-LR-N2012-1/50 is that in the new environment the workload can be smoothed out perfectly over a 24 hour day. In other words the workload is spread equally over the 24 hour day. However, given that the windows associated with each of the operations generally do not cover a 24 hour period, and there is scheduled downtime or maintenance time, *it is unlikely that the workload would indeed be spread evenly over 24 hours*. Take for instance cancellation operations. According to Figure 8 in USPS-T-4 cancellation operations are expected to take place between 5 pm and midnight. Further, since this workload is not available in advance like DPS sortation, it is unlikely that this volume could be spread evenly across the 7 hour window. Consequently, I went back into USPS-LR-N2012-1/50 and instead of distributing the workload over the 24 hours, I smoothed the workload evenly over the period in which it was expected to occur. In other words I followed the premise that the workload could be smoothed evenly (which to begin with is a big assumption and not clear if that can be achieved perfectly operationally), but conducted the smoothing of workload only over the window the operation was expected to occur. I then followed the identical methodology as witness Neri to compute the reduction in workforce requirements.

Product	**Window**
Letter	8 am to 4 am
Flat	8 am to 4 am
FSS	Noon to 6 am
Pkg	8 am to midnight
Cancellation	5 pm to midnight

The table above provides the windows over which the workload was smoothed. These are broadly based on Figure 8 of USPS-T-4. The calculation associated with these windows over which the workload is smoothed shows a decrease of 6.52 percent in staffing as opposed to the 28 percent in witness Neri's library reference.[12] The critical lesson here is that the window over which the traffic is smoothed plays a critical role in this productivity improvement calculation.[13] When that changes the productivity improvement value changes very significantly. It is clear that 24 hour workload smoothing is probably not achievable (given the windows proposed in Figure 8 of USPS-T-4). Thus the productivity improvement estimates as informed by USPS–LR-N2012-1/50 are likely to be significant overestimates.

A second factor is the arbitrary nature of the tours used. If it is possible to schedule 8 hour tours other than the ones used by witness Neri, and if labor contracts allow for tours with fewer work hours then the baseline calculation (from which the workforce savings and productivity improvement calculations are made) would be smaller (require less staff). This would substantially reduce any estimate of productivity improvements under the proposed service standard.

In summary, both the assumption that workload can be perfectly and evenly distributed over a 24 hour day, and the rigidity in the assumption of the 8 hour tours result in significantly overestimating the productivity savings. As mentioned previously, these productivity savings are used by witness Bradley to estimate a $964 million annual cost savings in productivity improvements in the rationalized mail processing

[12] My calculations are shown in PR-LR-N2012-1/3. My selection of windows may not be perfect and are my best attempt from Figure 8 of witness Neri. What should be clear though is when the workload is not smoothed over 24 hours as in USPS-LR50 the productivity improvements will be significantly less than 28%.

[13] In fact a change in the smoothed window for letters from noon to 4 am (from the values in the table) results in a loss in productivity!

network. My calculations would suggest they would be far lower than those implied by Figure 12 of witness Neri's testimony (and calculated by witness Bradley).

E. Evaluation of Witness Bradley's Analysis

I found the methodology underlying witness Bradley's testimony generally sound. What is of *<u>significant concern</u>* however is the fact that the savings calculations are heavily dependent on the transportation costs estimates produced by witness Martin, and the productivity improvement estimates produced by witness Neri. Given the uncertainty associated with these numbers and the likelihood that they are far less than in the original testimonies of witnesses Martin and Neri, it is unclear if the savings computed by witness Bradley can indeed be achieved under rationalized network in the proposed service standard.

III. OPTIMIZATION OF THE POSTAL SERVICE NETWORK UNDER CURRENT SERVICE STANDARD

A. The Need for a Comparative Analysis

The Postal Service's analysis focuses on optimizing the service network under the new service standard. The analysis is detailed. However, none of the analysis attempts to answer the question "Can one keep the current service standard and optimize the postal network?" Specifically, Postal Service witness Williams states "More importantly, the Postal Service has determined that, to align its infrastructure with current and projected mail volumes and to bring costs in line with revenues, it must also modify current First-Class Mail and related market-dominant product service standards on a system-wide basis." USPS-T-1 at 8. It would have been ideal if instead of solely focusing on the cost savings associated with the proposed service standard, the Postal Service had also conducted a similar network optimization analysis on the current network identifying opportunities to change mail processing windows, optimize their network by shutting down mail processing facilities, generating efficiencies in transportation, and by smoothing the workload to the extent possible within the current service standard. A comparison of the cost savings between maintaining the current service standard and the savings with the rationalized network under the proposed service standard, and the associated mail revenues under each of the two scenarios would go a long way in supporting the determination that the change in service standards is the best option for the Postal Service.

To that end to the extent possible I replicated the analysis of witness Rosenberg to determine the optimal number of facilities required under the current service standard and the optimal ZIP Code to mail processing facility assignments. Determining the number of facilities needed for a mail processing network under today's service standards and comparing that with the number of facilities required under the proposed service standard as well as the current number of mail processing facilities gives some sense of the possible savings achievable by optimizing the current network. The analysis described is similar to Postal Service witness Rosenberg's analysis, and is theoretical in the sense its results have not been vetted with Postal Service Area management expertise. To take this analysis to its logical conclusion, additional analysis needs to be conducted as was done by the Postal Service in the case of the rationalized network under the proposed service standard to obtain numerical estimates of cost savings. The aim of the analysis here is to 1) demonstrate that significant savings are potentially available by optimizing the current network, and 2) emphasize that quantifying the savings of the optimized network under the current service standard would provide a benchmark against which to compare the shift to the proposed service standard and the associated savings.

B. Determining the Number of Mail Processing Facilities under the Current Service Standard

I now describe how I applied the Logic Net optimization model under *an approximation of the current service standards*. Specifically, I adjust, to the best of my ability, the inputs to the Logic Net model so that they represent the demands, capacities, costs, and system constraints consistent with the current operating environment. As stated earlier, the goal is to develop a reasonable solution that can be used as a representative baseline mail processing network for comparative analysis.

I first describe the data inputs to witness Rosenberg's Logic Net model and the process by which I modified the inputs to model the mail processing network under the current service standards.

1. Data Inputs and Changes

Witness Rosenberg's Logic Net model considers 920 3-digit ZIP Code service areas; non-contiguous 3-digit ZIP Codes (all 3-digit ZIP Codes within Alaska, Hawaii, Puerto Rico, US Virgin Islands and Guam) are excluded from the analysis. Within the model, the "demand" of each customer (3-digit ZIP Code) is expressed in terms of the square footage required to process the mail generated by and delivered to that 3-digit ZIP Code (p. 15 of USPS T-3). That is, Rosenberg converts the mail volume associated with a 3-digit ZIP Code into a processing footprint by product (letter, flat, and parcel/bundle). The conversion from mail volume to processing footprint depends on the *machine characteristics* and the *operating window* for each processing step. These calculations are done within the worksheet "Model MODS" in Library Reference USPS-LR-N2012-1/13 (USPS-LR-N2012-1/NP2).

To use the Logic Net model for the current service standard, one can modify the values on the "Model MODS" worksheet for the operating time windows in cells A11 to H25 and the machine characteristics in cells A1 to D8. I first discuss how I modified the operating time windows.

Operating Time Windows: The operating time windows I use to model the current service standard are shown in Table 6 below. These operating windows are taken from Figure 5 of Postal Service witness Neri's testimony (page 13 of USPS T-4). The length of the operating window appears in the denominator of the square footage calculation equation, hence, the footprint requirement increases if one decreases the length of the operating window.[14] For most of the operations in Tables 6 the operating window is shorter under the current service standard than the proposed service standard. Therefore, one would expect the footprints to be larger in my Logic Net optimization model than in witness Rosenberg's model.

[14] To calculate a square footage requirement for each 3-digit ZIP Code by product and by process the following nine categories are considered: CANC, L-OGP, L-INP, L-INS1, L-INS2, F-OGP, F-INP, F-INS, and P/PRI-OGP/INP(a combination of P-OGP, P-INP, PRI-O, and PRI-I). Then, for each category, the square footage is calculated as follows:

$$\text{square footage} = \frac{\text{daily workload} \times \text{machine sq ft}}{\text{machine throughput} \times \text{length of processing window}}$$

For CANC, the machine is AFCS. For L-OGP, L-INP, L-INS1, and L-INS2, the machine is DBCS. For F-OGP, F-INP, and F-INS, the machine is AFSM100. For P/PRI-OGP/INP, the daily workload is the sum of the daily workloads for P-OGP, P-INP, PRI-O, and PRI-I, the machine is SPBS, and the length of the processing window is the sum of the window for PRI-O and PRI-I.

TABLE 6: Operating Windows used in my Logic Net Model[15]				
Operation	Machine	Start	End	Window
CANC	AFCS	15:00	21:30	6 hrs, 30 min
L-OGP	DBCS	16:00	23:00	7 hrs
L-OGS	DBCS	N/A	N/A	N/A
L-INP	DBCS	14:00	23:00	9 hrs
L-INS1	DBCS	23:00	28:00	5 hrs
L-INS2	DBCS	26:00	31:00	5 hrs
F-OGP	AFSM100	17:00	23:00	6 hrs
F-OGS	AFSM100	N/A	N/A	N/A
F-INP	AFSM100	14:00	23:00	9 hrs
F-INS	AFSM100	23:00	31:00	8 hrs
P-OGP	SPBS	17:00	23:00	6 hrs
P-INP	SPBS	14:00	23:00	9 hrs
PRI-O	SPBS	15:10	22:30	7 hrs, 20 min
PRI-I	SPBS	17:00	28:00	11 hrs

Machine Characteristics: Table 7 below describing machine throughput and square footage requirements is obtained from witness Rosenberg's testimony and worksheet "Model MODS" in USPS-LR-N2012-1/13. According to witness Rosenberg's testimony the equipment square footage in the column labeled "Actual" is from the Handbook AS-504 Space Requirements. USPS-T-3 at 18. The square footage in the

[15] This data is pulled from excel worksheet "Model MODS" in PR-LR-N2012-1/2. This is equivalent to excel worksheet "Model MODS" in USPS-LR-N2012-1/13.

column labeled "Model" is the square footage value that was used in the footprint calculations. She notes that the actual value was inflated "to ensure that there was adequate staging room under this new concept when all volume is available at the start of the windows." *Id.* Since I was modeling the current service standard I did not inflate the equipment square footage values and used the actual values.

Table 7: Machine Characteristics

		Sq Ft	
	Throughput	Actual	Model
AFCS	25,000	3,893	4,580
DBCS	27,500	2,491	2,931
AFSM100	13,500	7,792	9,167
SPBS	3,000	16,384	19,275
APPS		59,079	

Mail Processing Facility Capacity: In witness Rosenberg's model input files there are 476 candidate mail processing facilities.[16] Within the model, the capacity of each facility is expressed in terms of the facility's available square footage. The starting point for the available facility capacity is the current facility capacity, which was "acquired from the Facilities Database (FDB), USPS Facility Surveys, and current mail processing equipment sets" (*See* USPS T-3 at 14) and provided in library references USPS-LR-

[16] I note that some of these 476 facilities may already be closed, or otherwise under AMP study. Since, the purpose of this exercise was to obtain an estimate of the number of facilities needed for the current service standard, and is not a specific recommendation on which facilties (or plants) to keep open, I included all of the 476 candidate mail processing facilities in witness Rosenberg's model input files.

N2012-1/17 and USPS-LR-N2012-1/52 (Access database table "PLANTS"). Then, some adjustments are made. *See* USPS-T-3 at 16-17.

1. If the facility has no cancellation equipment, then its available capacity (square footage) for letter processing was set to one-third of the facility capacity to allow for additional travel time to an automated cancellation processing facility.
2. If a facility has no current cancellation workload and no automation equipment, then its available capacity (square footage) for letter processing was set to zero.
3. If a facility has no flat sorting equipment, then its available capacity (square footage) for flat processing was set to the maximum of 2000 square feet or 12.5 percent of its current square footage.
4. If a facility has no package sorting equipment, then its available capacity (square footage) for package sorting was set to the minimum of 13,500 square feet or 50 percent of its current square footage.

Outside of these conditions, the entire available square footage of a facility could be assigned to one product (letter, flat, or package) or divided among multiple products. For my model of the current service standard, I use these same capacity rules with minor adjustments as necessary for feasibility on a case by case basis as I discuss later.

Transportation Constraints: Under the proposed service standard modeled in witness Rosenberg's work, overnight service standards for first class mail are eliminated and hence additional transportation time is available. In witness Rosenberg's model, she assumes that each 3-digit ZIP Code workload can be transported up to 200 miles to be processed by a plant (*see* USPS-T-3 at 13). To incorporate the distance restriction into the Logic Net optimization model, witness Rosenberg defines mileage bands, which specify the maximum allowable distance between a customer and its assigned plant. Witness Rosenberg defines the following mileage bands:

GROUP_Under_100	GROUP_140_to_150
GROUP_100_to_110	GROUP_150_to_160
GROUP_110_to_120	GROUP_170_to_180
GROUP_120_to_130	GROUP_180_to_190
GROUP_130_to_140	GROUP_190_to_230

For all of the mileage bands except GROUP_190_to_230, the maximum distance is set to 200 in the PlantToCustomer lanes worksheet in USPS-LR-N2012-1/15. Each customer is assigned to one of the mileage band groups.[17]

To model the current service standard, which accommodates overnight service, I assume that a 3-digit ZIP Code workload could be transported up to about 100 miles (see footnote 4 on page 10). Looking at the worksheet "SiteDistances" in USPS-LR-N2012-1/15, I see that there are 3-digit ZIP Code service areas for which the minimum distance to a plant is more than 100 miles. Therefore, if I were to set 100 miles as the maximum distance, there would be no feasible solution. Instead, I need to set different

[17] In her response to PR/USPS-T3-33, witness Rosenberg describes how Logic Net was used to derive the mileage bands and the customer assignments. Due to the heuristic nature of the process, some customers are assigned to higher value mileage bands than necessary. For example, the minimum distance from 3-digit ZIP Code 768 to a plant is 136.2 miles. Although it could be assigned to the group GROUP_130_to_140, it is assigned to the group GROUP_150_to_160.

maximum values for different customers (3-digit ZIP Codes) to better approximate the current situation (where indeed there are 3-digit ZIP Code assignments to facilities that far exceed 100 miles).

I modify the mileage band assignments made by Rosenberg so that the mileage band assignment of a customer reflects the minimum distance to a mail processing plant. For example, the minimum distance from 3-digit ZIP Code 768 to a plant is 136.2 miles, so it is assigned to the group GROUP_130_to_140. Then, in the PlantToCustomer lanes input file, I set the maximum distance for each group equal to its upper bound value. For example, for the GROUP_Under_100, the maximum distance value is 100. For the GROUP_100_to_110, the maximum distance value is 110 miles, and so on.

For my model of current service standards, I consider two alternatives: (1) I assume that witness Rosenberg's assignment of 3-digit ZIP Codes to mileage bands is appropriate and (2) I modify that assignment of 3-digit ZIP Codes such that they reflect the minimum distance between a 3-digit ZIP Code and a plant. In both cases, I set the maximum distance value for each mileage band equal to its upper bound value. Note that, with witness Rosenberg's mileage bands, 795 of the 920 (86.4 percent) 3-digit ZIP Codes are in the GROUP_Under_100 group. With the revised mileage bands, 894 of the 920 3-digit ZIP Codes are in the GROUP_Under_100 group.

Cost Functions: For my Logic Net optimization model of current service standards, I use the same facility costs and transportation costs as witness Rosenberg.

2. Solving the Optimization Model

In this section, I describe the results of solving the Logic Net model under the current service standard.

I enforce the same system constraints as in witness Rosenberg's model: (1) all demand must be satisfied, (2) each 3-digit ZIP Code service area must be assigned to a mail processing facility within the maximum distance assigned to its mileage band, (3) all of the mail of a particular type (LTTR, FLAT, PRCL) must be processed at one plant and at most two plants can process mail volume for a single 3-digit ZIP Code, and (4) the total square footage required by all of the 3-digit ZIP Codes assigned to a facility must not exceed the facility's capacity.

I describe the results of the optimization using the mileage band (as described above) in two different ways.

<u>Alternative #1: Using Witness Rosenberg's 3-digit ZIP Code mileage band assignments</u>

When I solved the optimization model (setting the optimization gap to 0.25 percent), there were some minor infeasibility issues. The solver returns a partial solution where it can only satisfy 99.96 percent of the demand. While it appears that there is insufficient capacity available at the plants within the maximum allowable distance, closer examination reveals that this is not quite true. The source of infeasibility is not because the overall facility is at capacity but rather that the product specific capacity is depleted due to the capacity adjustment rules imposed by witness Rosenberg. *See* USPS-T-2 at 16-17. I relaxed these rules for 5 plants as described below.

Specifically Plant IDs 144, 200, and 396, correspond to Jackson, TN, Gaylord, MI, and Ely, NV respectively. Currently, none of these facilities has cancellation equipment, so the letter processing capacity was set to one third of the facility's capacity. Instead, I allow for the installation of cancellation equipment and allow the entire facility's capacity to be used for letter processing. Similarly, Plant ID 198 corresponding to Grand Rapids, MI has no package sorting or flat sorting equipment. Therefore, the space available for flat sorting and package sorting is limited according the capacity adjustment rules. I treat this facility as one with existing flat and package sorting equipment, thereby allowing the entire capacity of the facility to be used. Plant ID 395 corresponding to Las Vegas currently has no package sorting equipment. Given the large amount of square footage available, I allow the package sorting equipment to use as much space as necessary (as in facilities where there already exists package sorting equipment). Table 8 below summarizes these modifications.

Table 8: Capacity Adjustments in my Logic Net Model

Plant ID	Line	Line Option	Product	(old) Max Production	(new) Max Production
144	P144	Low Volume	LTTR	8644	25,931
198	P198	Low Volume	FLAT	2000	101,687
198	P198	Low Volume	SPBS	13,500	101,687
200	P200	Low Volume	LTTR	7080	21,264
395	P395	Low Volume	SPBS	13,500	176,812
396	P396	Low Volume	LTTR	1666	4998

When I run the optimization model with these changes, I get a feasible solution with an optimality gap[18] of 0.23 percent. This solution selects 239 plants overall. The solution activates 226 facilities for letter processing, 226 for flat processing, and 224 for package processing. The average travel distance (not weighted) is 52.87 miles. There are 2712 product lanes (3-digit ZIP Codes by product demand); 2450 of them have a distance less than or equal to 100 miles. The input files and the results for this optimization model are in PR-LR-N2012-1/2.

Alternative #2: Using the modified 3-digit ZIP Code mileage band assignments

Next, I modified the mileage band assignments for the 3-digit ZIP Codes as described above and solved the optimization model (keeping the facility capacity adjustments as described in Table 8 under Alternative #1). In addition to the above 6 facility capacity adjustments, I had to relax the capacity at one additional facility, Plant ID 470 corresponding to Moreno Valley, CA. It currently does not have packing sorting equipment, so its capacity was limited. I increase the package sorting capacity to a larger value. The specific adjustment is as follows:

Plant ID	Line	Line Option	Product	(old) Max Production	(new) Max Production
470	P470	Low Volume	SPBS	13,500	20,000

When I run the optimization model with this change, I get a feasible solution with an optimality gap of 0.25 percent. The solution selects 277 plants overall. The solution

[18] The optimality gap provides a worst-case scenario for how far the solution obtained is from the optimal solution to the problem. In this case, an optimality gap of 0.23% can be interpreted as follows. Although one does not know the optimal solution to the problem, the cost of the solution obtained by the software is provably within 0.23% of the optimal solution to the problem.

activates 264 facilities for letter processing, 265 for flat processing, and 264 for package processing. The average travel distance (not weighted) is 47.37 miles. There are 2712 product lanes (3-digit ZIP Codes by product demand); 2604 of them have a distance less than or equal to 100 miles. The input files and the results for this optimization model are in PR-LR-N2012-1/2.

Rather than focusing on the specific facilities opened under this Logic Net optimization model, which would be subject to change due to area management expertise, I would like to focus on the number of mail processing facilities. The rationalized network under the proposed mail processing standard will contain 199 mail processing facilities (per witness Rosenberg and witness Neri's testimony). My analysis shows that maintaining the current service standard, using the Postal Service's Logic Net model, results in a network that has somewhere between 239 and 277 facilities (the larger number of 3-digit ZIP Codes that are may be spaced more than a hundred miles from a facility, the fewer the number of facilities). Thus it should be clear that some significant savings could be achieved by optimizing the current mail processing network under today's service standard. While this saving would be less than that achievable by changing the service standard, it may have fewer risks associated with declines in revenue because of the change in service standard.

IV. SUMMARY AND CONCLUSIONS

In my testimony I have described my analysis of the optimization models used by the Postal Service in rationalizing their network under the proposed service standard.

Witness Rosenberg conducts a multi-stage analysis to design the rationalized network. The most significant concerns relating to this analysis lie with the scoring tool used to evaluate different operating windows, and some of the analysis associated with the detailed equipment modeling (specifically the lack of a detailed simulation analysis, and concerns related to peak volume and mail inventory within the mail processing network). Additional concerns related to the Optimization model are discussed within my testimony. Addressing the concerns related to the optimization model would help provide a better starting point for discussion with Area management expertise, as well as a more efficient network.

Witness Martin analyzed the savings in transportation costs under the proposed service standard. Witness Neri provides productivity improvement estimates based on the notion that under the proposed service standard the workload can be smoothed significantly. The intuition and premise behind the argument is logical. However, his estimates of productivity savings are informed by calculations where the entire workload is smoothed over a 24 hour period. This provides an overly optimistic estimate of the productivity improvements. When the workload is not smoothed over a 24 hour period the productivity estimates (using witness Neri's calculations) are significantly lower. Since both witnesses Martin and Neri's estimates inform witness Bradley's cost savings estimates, there is considerable doubt if the savings stated in witness Bradley's testimony can actually be achieved and is likely to be significantly lower than suggested in his testimony.

I also conducted an analysis to optimize the Postal Service's mail processing network under the current service standard. The aim of this analysis was to get a sense of the approximate number of mail processing facilities that would be required under the current service standard. To this end, I used the Postal Service's Logic Net optimization model, appropriately modified for the current service standard. This analysis suggests that the Postal Service can potentially maintain the current service standard, and obtain considerable costs savings by optimizing their mail processing network.

In summary, it is clear that with the significant decline of mail in the Postal Service there are significant opportunities to optimize the mail network and reduce costs. This will eliminate excess capacity in the network. However, the computation of cost savings by the Postal Service is informed by analysis that at the present stage is not precise. Consequently this overestimates the savings associated with the rationalized network under the proposed service standard. By my analysis of the optimization of the Postal Service network under the current service standard, it would appear that there also exist considerable cost savings opportunities under the current service standard. In evaluating the Postal Service's proposal to change the current service standard and to rationalize the network, it would be of considerable benefit to provide a comparative analysis of the cost savings and revenue estimates associated with both the optimized network under the proposed and current service standards.